reinforcing elements--.

REMARKS

The applicants appreciate the Examiner's thorough examination of the application and request reexamination and reconsideration of the application in view of the preceding amendments and the following remarks.

The applicants have amended the independent claims of the subject application in order to make it clear that the step of inserting the reinforcing elements through the thickness of each composite adherend to be joined involves obtaining extrinsic reinforcing elements and then disposing them through the thickness of each composite adherend in a direction transverse to the direction of the fibers inherent within the composite adherends.

The Examiner states that the previous language "disposing...elements through the thickness" does not exclude the reinforcing fibers or elements of the art (Born) since the fibers therein were disposed throughout the articles".

Born's fibers, however, are <u>inherent</u> within the long plastic rods and he does not teach or suggest using extrinsic reinforcing elements of sufficient length to extend through the thickness of each plastic rod in a direction transverse to the direction to the fibers inherent in the rods.

The applicant claims inserting <u>extrinsic</u> reinforcing elements <u>through the thickness</u> of each composite adherend.

Born, in contrast, merely "frees" inherent, not extrinsic, fibers from the surrounding resin over a length of 1-30 mm <u>by grinding</u>. See column 1, lines 50-61. Born does not teach or suggest <u>inserting</u> <u>additional</u> <u>extrinsic</u> reinforcing elements <u>through the thickness</u> of each adherend.

Born teaches away from <u>inserting extrinsic</u> reinforcing elements through the thickness of each adherend since he teaches <u>grinding</u> the parts. Moreover, it is probably impossible to insert extrinsic reinforcing elements through the thickness of long, thin, small diameter (1.5mm) plastic rods. See Born, column 1, lines 45-49.

The applicant inserts <u>extrinsic</u> reinforcing elements of sufficient length such that they extend through the thickness of each adherend. Born, in contrast, <u>removes</u> resin material to expose a few inherent fibers over a length of from 1-30 mm along the 1.5mm diameter plastic rod. These few inherent fibers do <u>not</u> extend <u>through the thickness</u> of the glass rods nor are they extending at the joint region as claimed by the applicant.

The '035 publication is non-analogous art. Obviousness is properly found if "the differences between the subject matter sought to be patented and the prior art are such that the subject mater as a whole would have been obvious at the time when the invention was made to a person having ordinary skill in the art...". 35 USC Section 103.

A prerequisite, then, for making an obviousness determination, is that the "prior art" cited by the Examiner

be analogous to the subject matter claimed by the applicant. See <u>In re Clay</u>, 23 USPQ 2d 1058, 1059 (CAFC 1992) (and cases cited therein).

> Two criteria have evolved for determining whether prior art is analogous: (1) whether the art is from the same field of endeavor regardless of the problem addressed, and (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved.

For example, in the case of <u>In re Oetiker</u>, 24 USPQ 2d 143, Oetiker invented a metal hose clamp improved with a preassembly hook. The cited references were Oetiker's earlier patent which showed a hose clamp without a hook and Lauro which showed a hook for use in fastening garments. <u>Id.</u> at 1445.

Although Oetiker argued that the Lauro reference directed to fasteners for garments was not analogous to the hose clamp art, the Examiner was not persuaded. The Examiner held that "since garments commonly use hooks for securing", a person forced with the problem of unreliable maintenance of the pre-assembly configuration of an assembly line metal hose clamp would look to the garment industry art. <u>Id.</u> The Board upheld the Examiner's finding that all hooking problems are analogous. <u>Id.</u>

The CAFC however, held that the Examiner and the Board were wrong. The CAFC held that "common sense" must be used in deciding which fields a person of ordinary skill would reasonably be expected to look for a solution to the problem facing the inventor". <u>Id.</u> at 1446.

It has not been shown that a person of ordinary skill, seeking to solve a problem of fastening a hose clamp, would reasonably be expected or motivated to look to fasteners for garments. The combination of elements from non-analogous sources, in a manner that reconstructs the applicants invention only with the benefit of hindsight, is insufficient to present a *prima facie* case of obviousness. There must be some reason, suggestion, or motivation found in the prior art whereby a person of ordinary skill in the field of the invention would make the combination. That knowledge can not come from the applicant's invention itself.

> Oetiker's invention is simple. Simplicity is not inimical to patentability. See Goodyear Tire & Rubber Co., v. Ray-O-Vac Co., 321 U.S. 275, 279, 60 USPQ 386, 388 (1944) (simplicity of itself does not negate invention); Panduit Corp. v. Dennison Mfg Co., 810 F.2d 1561, 1572, 1 USPQ2d 1593, 1600 (Fed. Cir.) (the patent system is not foreclosed to those who make simple inventions). cert. denied, 481 U.S. 1052 (1987).

Id.

Therefore, the CAFC held that a garment industry hook was not "from the same field of endeavor" and not "reasonably pertinent to the particular problem with which the invention is involved" as required for a Section 103 rejection under the law of Clay, supra.

Similarly, here, a conveyor belt is not from the same field of endeavor and it is not reasonably pertinent to the particular problem with which the applicants invention is involved. Conveyor belts are not analogous to composite components including plies of fabric each including an array

of inherent fibers in a resin matrix. See the applicants' specification, page 3, lines 8-18.

Even so, the <u>intrinsic</u> strands of the conveyor belt shown in the '035 publication are <u>exposed</u> in contrast to <u>inserting extrinsic</u> reinforcing elements <u>through the thickness</u> of the conveyor belt which is probably impossible since rods or fibers could not be inserted through a conveyor belt.

Holko's carbon-carbon composite adherends include an intrinsic carbon fibers <u>throughout</u> the thickness thereof as noted by the Examiner but not <u>extending through the thickness thereof</u> as claimed by the applicants. Moreover, Holko fails to teach or suggest inserting extrinsic reinforcing elements through the thickness of each composite adherend.

The Examiner states that Holko does not specifically disclose that the reinforcing fibers in the composites extend from the surfaces thereof. In fact, he teaches <u>away</u> from such a manufacturing step since he <u>grinds</u> the surfaces smooth: "the material was 1/4" thick and was cut into specimens of 3/8' by 3/8'. Surfacing was done with a milling cutter to a surface finish of about 8 rms". Column 2 line 67 through columns 6, line 3.

Accordingly, Holko teaches <u>away</u> from inserting extrinsic reinforcing elements through the thickness of each composite adherend and leaving the reinforcing elements extending at the joint surface. The reinforcing elements

cannot be left extending in the joint surface if the surfacing milling cutter is used according to Holko.

Claim 24 recites:

> A method of joining composite parts comprising: inserting a plurality of <u>extrinsic</u> reinforcing elements <u>each extending through the thickness</u> of two composites adherands to be joined, each composite adherend containing fibers in a resin matrix, said reinforcing elements inserted <u>transverse</u> to the direction of the fibers in resin matrix, said reinforcing elements <u>left extending</u> from the joint surface of each adherend;
>
> assembling said adherends one on top of the other so that the joint surface of one said adherend faces the joint surface of the other said adherend defining a joint region therebetween, said <u>extending</u> reinforcing elements <u>interstitially disposed in said joint region</u>; and
>
> disposing an adherent within said joint region about said interstitially disposed reinforcing elements and said joint surfaces.

The Examiner cites the 783035 publication stating that the "strands" of this reference can be seen to be equivalent to the reinforcing elements claimed by the applicants. The "strands" referred in this publication, however, run <u>longitudinally</u> or in the direction of the belt, not "<u>transverse</u> to the direction of the fibers" as claimed by the applicant. Moreover, the <u>inherent</u> strands are <u>not</u> extrinsic nor are they "inserted <u>through the thickness</u> of the two composite adherends" as claimed by the applicants prior to forming a joint.

Instead, "the ends of the ropes (cables) are separated and divided into their strands". See the abstract. This is completely different from the claimed methodology which requires that <u>extrinsic</u> reinforcing elements are <u>inserted</u>

through the thickness of two composite parts in the direction transverse to the direction of the plies of fibers already in (inherent) the composite parts.

The applicants insert extrinsic rods transversely through the plies; the reference merely separates and divides the longitudinally running plies to reveal the individual longitudinally running strands.

The Examiner also feels that Holko teaches the steps of disposing or inserting reinforcing elements through the thickness of a composite part citing columns 2, lines 11-43, 52-60 and claim 1. Column 2, lines 11-43 and 52-60 in claim 1 are repeated here verbatim:

> The present invention may be described by reference to the drawings.
>
> Carbon-carbon composite components 1 and 2 are to be joined. The surfaces to be joined 3 and 4 are prepared so that they match. (The surfaces may be serrated to increase the joint area as shown in Fig. 1B). The surfaces are cleaned and loose material is removed. A thin interlayer 5 is assembled between surfaces 3 and 4 as shown in Fig. 1C and the assembly is heated at a temperature at or above the melting point of the interlayer material or at a temperature sufficient to cause interdifussion between the interlayer and the carbon-carbon composite. During the heating process the assembly is held together under compression by clamp 6. The heating is done in a vacuum, in an inert gas atmosphere or in an atmosphere which will produce or enhance the desired chemical reactions. The assembly is then cooled.
>
> An enlargement of a typical completed joint is shown in Fig. 2. As shown at 7, the interlayer material has diffused into the material of components 1 and 2 and the composite material has diffused into the interlayer material. Interdiffusion is generally limited to about 0.010 inch, but in cases here the interlayer has been

forced to melt, the inventor has observed evidence of the flow of liquid metal up to 0.060 inch into the carbon-carbon material.

Interlayer materials are selected from reactive and refractory metals and compounds or other materials that will react during the joining process to produce refractory, high temperature compounds. The interlayers may be applied in the form of foils, compound powders, mixtures of elemental powders, or mixtures of compound and/or elemental powders.

In order to improve bonding, carbon-carbon surfaces may be modified by ion implantation or ion mixing. Ion implantation involved propelling ions toward the sources. The ions are embedded to a depth of up to several hundred angstroms into the carbon-carbon microstructure. Ion mixture involves first coating the surfaces by a process such as sputtering or chemical vapor deposition then bombarding the surface with high energy ions. Coating and components atoms are thus mixed together.

•••

1. A process for joining carbon-carbon composite component comprising the steps of:

(a) preparing the surface of a first carbon-carbon composite component to be joined,

(b) preparing a surface of a second carbon-carbon composite component so that the surface of said second component <u>mates with</u> said prepared surface of said first component,

(c) preparing a thin interlayer having a thickness of between 0.001 inch and 0.004 inch and comprised of material having a melting point greater than 2500F.

(d) assembling said first component, said interlayer and said second component so that said mating surfaces are <u>facing each other with said interlayer sandwiched between</u>, and

(e) while holding said assembly together under compression, heating for a time said assembly at a temperature not exceeding 36650 F. but sufficient to cause substantial mixing of the atoms of the interlayer with the atoms of the carbon-carbon composite.

Holko describes serrating the surfaces (Fig. 1B) but it

can clearly be seen that no reinforcing elements are inserted into the part or are left extending from the joint surface of each adherend as claimed by the applicants in claim 24. Compare Holko, Figs. 1B and 1C with the applicants' Figs. 2, 3, and 4. Note, column 2, line 63 through column 3, line 1: Holko machines each part to a surface finish to about 8 RMS. Clearly there are no reinforcing elements left extending at the joint region if the surfaces of each part is machined.

Clearly Holko fails to teach inserting extrinsic reinforcing elements through the thickness of two composite adherends to be joined in a direction transverse to the direction of the plies of fibers. Clearly Holko fails to teach or suggest disposing an adherent within the joint region about the interstitially disposed extrinsic reinforcing elements. Holko also describes various interlayer materials such as Zr and ZrC and ion implantation wherein the ions are "imbedded" to a depth of up to several hundred angstroms into the carbon-carbon microstructure. This is not, however, the equivalent of driving extrinsic reinforcing elements through the thickness of each adherend in a direction transverse to the plies of fibers in the resin matrix and leaving them extending prior to disposing an adherent between the two adherends and about the interstitially disposed extending reinforcing elements.

No art suggests a method of joining composite parts comprising: inserting a plurality of extrinsic reinforcing

elements through the thickness of two composites adherends to be joined, each composite adherend containing inherent fibers in a resin matrix, the extrinsic reinforcing elements inserted transverse to the direction of the intrinsic fibers in resin matrix, the extrinsic reinforcing elements left extending from the joint surface of each adherend; assembling the adherends one on top of the other so that the joint surface of one adherend faces the joint surface of the other said adherend defining a joint region therebetween, the extending reinforcing elements interstitially disposed in the joint region; and disposing an adherent within the joint region about the interstitially disposed reinforcing elements and the joint surfaces.

Also, the applicants claim that the composite parts may be in the form of a "prepreg" material before the extrinsic reinforcing elements are inserted and the joint is made. The joined assembly is then cured. See claim 7.

The publication clearly fails to show the use of "prepreg" materials and instead is related only to conveyor belts. Conveyor belts are simply not formed from "prepreg" material. Holko specifically teaches using cured composite material from General Dynamics known as "K-Carb". Clearly, there is no teaching related to the use of "prepregs" which more easily accept the extrinsic reinforcing elements, the use of a prepreg material as the adherent, and the step of curing a completed joined assembly as claimed by the applicants.

Born discloses joining the ends of thin rods by grinding each rod to a taper and exposing the fibers. The rods are then overlapped and glued together. A heat shrink tube may also be placed over the joint region. In contrast, the applicants claim, not grinding to expose fibers, but disposing (inserting) a plurality of extrinsic reinforcing elements through the thickness of each composite part. The reinforcing elements are left extending at the joint region and interlock within the adherent to form a very strong joint.

Born teaches grinding to expose the fibers of a rod; the applicants claim inserting extrinsic reinforcing elements and leaving them extending. Born teaches away from this claimed feature since any grinding would grind the reinforcing elements flush and the applicants specifically claim that the reinforcing elements are left extending. Were reinforcing elements actually disposed through the thickness of Born's thin rods (probably impossible), the subsequent grinding operation would render them useless. Born teaches only the joining of thin rods since he specifically teaches using a heat shrink tube over the joint between two rods. This tapering operation by grinding is not applicable to composite parts other than long thin rods.

The 783035 publication relates to joining the ends of a conveyor belt. Longitudinal cables in the belt are exposed and a butt joint of overlapped cables is formed.

Inserting reinforcing elements through the thickness of

these flexible belts is neither taught nor suggested since the very idea would be antithetical to standard engineering practices relating to flexible belts.

Extending reinforcing elements through the thickness of a belt and/or a belt joined to another belt by placing one belt <u>on top of another</u> (see claim 24) would render the belt inoperable on a conveyor. This is why the 783035 publication teaches joining the <u>ends</u> of the conveyor belts. There is no discussion or suggestion relating to inserting reinforcing elements through the thickness of a part as claimed by the applicant.

Holko <u>does</u> teach joining composite materials (one "adherend" placed on top of the other "adherend") so Holko is analogous art, but it is the <u>prior art</u> shown in Fig. 1 of applicant's specification. It is this art which the applicant improves upon in the claimed methodology.

The Examiner states that Holko teaches disposing a plurality of reinforcing elements through the thickness thereof. This is not true. Composite parts <u>inherently</u> comprise <u>fibers</u> in a resin matrix. Holko, column 1, lines 14-30. See also the Engineer's Guide to Composite Materials and Engineered Materials Handbook. See also Born, column 1, lines 10-14.

Neither Holko nor Born, however, teach the applicants <u>extra</u> step of disposing or inserting <u>additional</u> <u>extrinsic</u> reinforcing elements <u>through the thickness of a composite</u> part which already contains inherent fibers in a resin

matrix, <u>and</u> leaving them extending, <u>and</u> placing them on top of each other at the joint region, <u>and</u> interstitially disposing them in the joint region, <u>and</u> disposing an adherent about the extending reinforcing elements.

The applicants specification clearly defines the language "disposing reinforcing elements through the thickness of each composite adherand", see Figs. 11-14, and the art cited fails to teach or suggest this step. Before the present invention, the applicants use to <u>grind</u> the extending reinforcing elements <u>flush!</u>. See Boyce. It was not until <u>this</u> invention that the applicants discovered that by leaving the reinforcing elements extending, a stronger joint between the two parts could be fabricated.

The Examiner contends that claims 1, 3, 7, 9-15 and 19 are obvious in light of Boyce et al. ('461).

Applicants submit that Boyce is an improper §103 reference because it fails to disclose or infer: separately disposing <u>two</u> sets of reinforcing elements through <u>two</u> parts to be joined; leaving the reinforcing elements <u>extending</u> from the surface of the parts; assembling the parts so that the extending elements face each other; disposing an <u>adherent layer</u> between the parts; and inserting the pins that extend out of one part into the other part (and vice versa). See claim 1.

The Examiner states that Boyce discloses a method of preparing composite structures which includes inserting reinforcing elements into a <u>single</u> improved composite part

as illustrated in Figs. 4 and 5.

This is true, but applicants in the instant application claim inserting separate extrinsic reinforcing elements into two parts (adherends) to be joined.

In an attempt to meet this claim language, the Examiner states that reinforcing structure 10 (a thermally decomposable foam) in Boyce is a second part to be joined.

This allegation is false. Decomposable foam body 10 is not a composite part to be joined to another composite part. Instead, decomposable foam body 10 is a vehicle for inserting reinforcing elements into a single composite part.

Foam body 10 decomposes under the elevated temperature and pressure of this methodology and collapses. (Col. 5, lines 46-64). In the final step it is scraped off the reinforced part. (Col. 4, lines 2-6; Fig. 6 and claim 18).

Boyce, to be a proper §103 reference must disclose or suggest the claimed combination of elements in applicants invention. As the CCPA held in In re Civitello, 144 USPQ 10, 12 (1964), rejection would be especially improper here since, as a matter of fact, many of applicants' claimed features are not even shown, in Boyce:

> Since...[the reference] fails to disclose the feature of the claim relied on, we do not agree with the Patent Office that it would suggest modifying the ...[prior art device] to contain that feature. The Patent Office finds the suggestion only after making a modification which is not suggested, as we see it, by anything other than appellant's own disclosure. This is hindsight reconstruction. It does not establish obviousness. We therefore find claim 2 allowable over the references applied.

Nowhere does Boyce disclose or infer applicants' method of joining two structures by inserting extrinsic reinforcing elements into both parts separately and then pressing these parts with their extending elements together.

Boyce does teach a method of inserting reinforcing elements 14, Fig. 1 into a prepreg 30 (a single part) to reinforce that single part. Boyce teaches first placing these reinforcing elements in a thermally decomposable foam body 10. This body is then placed on prepreg 30, heated, and subjected to elevated pressures (Fig. 5) so that the reinforcing elements are driven "into a composite structure [prepreg 30] as said thermally decomposable material collapses under the influence of said elevated temperature and pressure" (Column 5, lines 46-64). Then, the residue of the thermally decomposable foam body 10 is scrapped off (Column 4, line 2-6; Fig. 6; claim 18). Body 10 and prepreg 30 are never joined!.

Boyce also fails to teach or suggest applicants' claimed joint region including the adherent and the reinforcing elements extending from both surfaces. (See appellants' claim 1, lines 8-13) (Also note 30 in Fig. 4 of appellants' application in contrast to Figs 4, 5 and 6 of the Boyce reference).

Instead, Boyce specifically teaches that once the reinforcing elements are inserted into the composite part, any portion of these elements extending from the surface of the composite are ground flush as indicated in Fig.7.

This is contrary to applicants' present invention which claims leaving the reinforcing elements extending out of each adherend before they are ultimately pressed together (See applicants' claim 1, lines 3-5).

Although the Examiner does not discuss Fig. 8 of Boyce, it is appropriate to do so here. At first blush it may seem that Fig. 8 of Boyce discloses a method of joining two parts together.

This, however, is not true. Although Fig. 8, of Boyce does illustrate inserting reinforcing fibers 14' in critical areas to another composites stiffening stringers 56 and 58 (which are then co-cured with the composite laminates 60), this methodology involves driving a single set of reinforcing fibers 14' through both stiffening stringers 56, 58 and 60 at the same time. Therefore, Boyce's reinforcing fibers 14 are continuous in nature in that a single fiber is driven through both parts to be joined.

Applicants', on the other hand, now disclose and claim the use of two sets of extrinsic reinforcing elements which are separately driving through two different parts such that the exposed ends are staggered from one another. (See applicants' claim 1, lines 2-3) (Also note reinforcing elements 14 and 16 in Fig. 2 of applicants' application and note their orientation, 32 in Fig. 4).

The advantage over the method shown in Fig. 8 of Boyce is that one part can now be manufactured and cured and then later joined to another already manufactured and cured part.

This is <u>not possible</u> in Fig. 8 of Boyce. Also, note the lack of an adherent in Boyce, Fig. 8. Applicants' specifically claim "disposing an adherent with said joint region..." (See appllicants' claim 1, lines 10-13).

<u>Such a suggestion or inference cannot be found in Boyce</u>. The Federal Circuit, has held that the mere fact that the prior art <u>could</u> be modified does not make the modification obvious unless the <u>prior art suggests</u> the desirability of the modification <u>In re Gordon</u>, 221 USPQ 1125, 1127 (Fed. Cir. 1984). "The claimed invention <u>must</u> be considered as a <u>whole</u>, and the question is whether there is something in the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination". <u>Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick</u>, 221 USPQ 81, 488 (Fed. Cir. 1984).

> Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination. Under Section 103, teachings of references can be combined <u>only</u> if there is some suggestion or incentive to do so. <u>ACS Hospital Systems, Inc. v. Montefiore Hospital</u>, 221 USPQ 929, 933 (Fed. Cir. 1984) (emphasis in original, footnotes omitted).

Applicants' claimed invention is <u>not</u> obvious over Boyce. Boyce fails to teach or suggest "A method of <u>joining</u> composite parts" See claim 1.

Boyce fails to teach or suggest "disposing a plurality of extrinsic reinforcing elements through the thickness of <u>two</u> composite adherends to be joined". <u>Id.</u>

Boyce fails to teach or suggest "at least a number of

said extrinsic reinforcing elements extending from the joint surface of each said adherend" Id.

Boyce fails to teach or suggest "assembling said adherends so that the joint surface of one said adherend faces the joint surface of the other said adherend" Id.

Boyce fails to teach or suggest a defined "joint region therebetween, said extending reinforcing elements interstitially disposed in said joint region" Id.

Boyce fails to teach or suggest "disposing an adherent within said joint region about said interstitially disposed reinforcing elements and said joint surfaces". Id.

Boyce, in contrast, specifically teaches that foam body 10 is not joined to a composite part, that it is "scraped off" the part after it is used, and that the reinforcing elements are ground flush after they are inserted. Boyce also fails to mention or disclose an adherent or a reinforced joint.

Applicants' claimed methodology allows the composite parts (after receiving the reinforcing elements) to be cured in separate steps. In other words, each adherend, after having extrinsic reinforcing elements inserted therein can then be separately cured prior to being joined. This allows manufacture of the two parts to occur separately save for the steps of joining and then curing the adherent interlayer and the now bonded parts. In this way, a cured stringer can be joined to a cured fuselage at the Boeing assembly plant.

In comparison, stiffening stringers 56 and 58 and

composite laminate 60 of Boyce are <u>co-cured</u> after a <u>single</u> set of reinforcing fibers 14' are inserted through both parts. (See column 4, line 23).

Further, Boyce does not disclose nor infer the use of an adherent between stiffening stringers 56, 58 and composite laminate 60 or between foam body 12 and composite prepreg 30.

Applicants, in comparison, claim disposing an adherent within the joint region and that this adherent is urged to flow at least partially along the length of the <u>extending</u> reinforcing elements now embedded within the opposing part. (See claim 12) This is more dramatically illustrated in Fig. 4 where the adherent flows into area 34 for an even greater cohesive bond.

Therefore, applicants' respectfully assert that Boyce does not render applicants' claimed invention obvious. In fact, Boyce is only a distant precursor to the technology applicants' now claim.

Not only does Boyce <u>not teach the joining of two</u> composite parts, as applicants do, Boyce also fails to claim the use of an <u>adherent</u> within the joint region between these two parts.

Each of Examiner's rejections has been addressed or traversed. Accordingly, it is respectfully submitted that the application is in condition for allowance. Early and favorable action is respectfully requested.

If for any reason this Response is found to be

incomplete, or if at any time it appears that a telephone conference with counsel would help advance prosecution, please telephone the undersigned or his associate, Joseph S. Iandiorio, collect in Waltham, Massachusetts, (617) 890-5678.

Respectfully submitted,

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